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Beyond the Isomorphistic View of the Academic Entrepreneur; An empirical exploration of norms and values of knowledge dissemination of university scientists

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Abstract

The paper contributes to the policy discussion on the new, entrepreneurial role of universities in knowledge-based economies. Whereas most contributions on academic entrepreneurship and knowledge-transfer focuses on the organizational and policy level, we focus on the micro norms, values and routines of knowledge dissemination of the individual faculty members and question if, and to what extent, these are converging to norms of entrepreneurial science.

In order to do so, we build on new empirical data, gathered between October 2005 and January 2006. It concerns four biotechnology cases of basic research units at two research universities in the Netherlands and two in the United Kingdom.

We conclude with policy implication and assess whether the micro level data is congruent with the organizational convergence towards entrepreneurial universities in knowledge-based economies.

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1. Introduction

We start this paper with the premise that universities are playing an increasing important role in knowledge-based economies. Whereas traditionally, universities were expected to educate students and contribute to 'basic' research, which could be freely used by society, the last decades they are expected to contribute more substantially and directly to the competitiveness of the firms and societies (e.g. Zaharia and Gilbert, 2005). This has resulted in a discussion on the new role of universities and a renewed focus on their third mission activities. An 'ideal-type' of entrepreneurial university has emerged in the policy documents of most countries and strategies of universities focusing on university patenting, licensing and spin-offs. Herewith, universities as organizations seem to be converging to academic research enterprises, expecting the university scientists to behave more and more as academic entrepreneurs.

It seems that most literature on academic entrepreneurship take this tendency of organizational convergence as a given and adopt the isomorphistic[2] (policy) perception of the 'one-size-fits-all' entrepreneurial university. The focus of most contributions in this literature is on determinants of academic entrepreneurship, effectiveness of technology transfer policy instruments (such as spin-offs) or the optimal conditions for academic entrepreneurship. Recently, however, several contributions in the literature on academic entrepreneurship and technology transfer criticize this one-size –fits all perception of the entrepreneurial university (e.g. Litan et al, 2007). Their criticism focuses on the organizational and policy level.

One of our main assumptions is that the individual faculty member is at the heart of university knowledge transfer and academic entrepreneurial activities. Therefore, our research focuses on the micro level of the university scientists who is motivated by a set of personal and institutional incentives (Bercovitz and Feldmann, 2005:180) and question

[2] The notion of 'isomorphistic' is adopted from the seminal article of DiMaggio and Powell (1983).

whether the norms, values of university scientists are converging to a new value system of professional, entrepreneurial behavior.

In order to do so, this paper explores the norms, values and patterns of university-industry knowledge transfer of university scientists in biotechnology. Biotechnology is compared to other academic disciplines often associated with entrepreneurial activities and therefore we would expect that these faculty members have adopted entrepreneurial norms and values and act accordingly.

We question if, and to what extent, the norms and values of the university scientists of biotechnology research units are still dominated by traditional academic value systems (e.g. Merton, 1973; Dasgupta and David, 1994) or as suggested by Etzkowitz (1998), Ziman (2001) and empirically for instance by Tijssen et al (1996), Tijssen (2004) in particular in biotechnology see for instance Owen-Smith and Powell (2003) and Ebers & Powell (2007) that the behaviors of scientists are converging more and more to norms of entrepreneurial science. Based on Merton (1973) we focus specifically on norms embedded in values of the social structure of the scientific community, such as communalism, universalism, disinterestedness, originality, and scepticism as well as more recent professional norms among researchers as developed by Ziman (2001) such as proprietary, local, authoritarian, commissioned expert work which manifest themselves in research transfer activities of academics. The empirical data, collected in 2005, will allow us to explore the norms, values and routines of knowledge dissemination in the field of biotechnology.

The paper is organized as follows. Section 2 discusses the literature on norms and values of scientific and entrepreneurial science and formulates propositions. Section 3 discusses the methodology and data of our cases. Section 4 presents the empirical outcomes of our analysis on entrepreneurial and scientific behavior of the university scientists in our dataset. Finally, section 5 concludes with summary of the results and policy implications.

2. Literature on norms, values and routines of university scientists

Dasgupta and David (1994) argue that on a fundamental level there are two archetypes of schemes based on researcher's attitudes toward controlling the output of research, namely the community of science which is concerned with additions to the stock of public knowledge whereas the community of technology is concerned with adding to rents that may be derived from possession of rights to use private knowledge. In order to analyze our main question whether the attitudes of university scientists are indeed shifting towards the community of technology, we will first discuss the norms, values and behavior associated with both archetypes as well as the empirical literature on behaviors of university scientists in biotechnology. So, section 2.1 discusses traditional norms and values of scientists (community of science), section 2.2 the empirical literature and section 2.3 focuses on the professional norms and values associated with the 'academic entrepreneur' (community of technology). Finally, based on the literature, section 2.4 presents a framework of propositions on values and norms of knowledge dissemination of university scientists.

2.1 Traditional norms and values of university scientists

According to the economics of science there are fundamental differences in the socio-economic rule structures under which the research takes place and how the researchers disclose their knowledge do with their findings (Dasgupta and David, 1994: 495). Firms pursue private science through patenting and universities support public science through publishing. Research undertaken with the intention of selling the outcomes into secrecy belongs to the community of technology, in the case of this study, biotechnology. With applied industrial scientists the balance between codified and tacit knowledge, i.e. practical know-how tilts more towards the latter than it is the case among university researchers. Research and innovative activities in industry are based on pecuniary goals, while advancement in academia is based on peer-review and priority of discovery (Merton 1973).

In universities what traditionally makes research credible is its acceptance and approval by the academic community. As Merton states: “The ethos of science is that affectively toned complex of values and norms which is held to be binding to the man of science” (1968, p. 605). In other words, academic scientist behavioural practices should be understood in relation to the academic community, which represents the set of norms embedded in the social structure that surrounds science. The norms of communalism, universalism, disinterestedness, originality, and scepticism are the core of it as derived from Merton (Merton, 1973). However, Mertonian science was never completely ‘pure’ since the interests of governments and bureaucracy in the utility of science were always present to some extent (Elzinga, 1985). There is an argument that norms embedded in values of the social structure that surrounds science and the recent professional shift towards more professional norms among researchers; namely proprietary, local, authoritarian, commissioned expert work (Ziman, 2000) manifest themselves in research transfer activities of academics as well.

As their innovation activities are guided by different institutions and incentive structures between academics (David and Foray, 2001), this may harm effective university-industry knowledge transfer. The norms and values and herewith routines of academic scientists (community of science) with regard to values, norms and routines of knowledge dissemination differ from those of researchers in the private sector.

The community of science is ruled by a reward system effective in creating incentives to the production of public knowledge (e.g. David and Foray, 2001; Stephan, 1996, Stephan, 2004) is based on priority and the constitution of reputation that creates competition, compatible with the disclosure of knowledge. The principle of reputational rewards for the one who discovers creates a knowledge system that forces people to release new knowledge quickly and completely. The new technical knowledge diffuses through various channels into the economy, such as publications and licenses to firms.

Priority of discovery and development is the basic value for *reputation-building.* This means that the individual scientists reputation for contributions acknowledged within his or her collegiate reference groups is the fundamental value in the reward structure that governs the community of scientists (Merton, 1973; Dasgupta and David 1994: 498). The quality of published research was the most important determinant of recognition that came in the forms of honorific awards, appointments to professorships at prestigious departments and wide citation.

This explains races for priority and priority disputes in science. Scientists are motivated to establish claims of priority because they seek fame through the attachment of their name to a discovery or hypothesis. Creative individuals need to secure their validation of their creation from an expert audience that provides them with the feeling of having produced something new to the world and not just to the self (see Dasgupta and David 1994). In the context of the reward system in science, the rule of priority serves two purposes at once, hastening discoveries and hastening their disclosure.

2.2 Empirical literature on norms, values and habits of university scientists

The notions of values, norms and habits of university scientists are closely interlinked. Values are engrained feelings of right, wrong and what is justified either in society or in a group related to the art of science. These are closely interconnected with the norms, which are practical guidelines that regulate daily behavior of a group and in our case, scientists. Norms can be formal in terms of rules but most often they are informal guidelines that tell you of what you ought to do or ought not to do. The daily behavior regulated by the embedded values and norms of an individual scientist are habits of thought and habits of action referring to ‘a more or less self-actuating tendency to engage in a previously adopted or acquired form of action (see for the reference of Camic, 1986: 1044, in: Van der Steen (1999: 101).[3] Habits determine the daily choice of action of individuals. “When habits become a part of a group or social culture of an organization, they grow into routines (Commons, 1934: 45). Typically, habits are implanted in other individuals by repeated imitation.” (Van der Steen, 1999: 101) In the following section we discuss the values, norms and habits of scientists in their scientific and dissemination routines.

[3] See Van der Steen (1999), for a full discussion on norms, values, habits and routines of behavior.

Recent empirical studies demonstrate however that the institutional dichotomy between university scientists versus business R&D researchers as proposed by the economics of science is not so straightforward in practice. Empirical studies of for instance Owen Smith and Powell (2003), Ebers and Powell (2007), Tijssen et al (1996), Tijssen (2004) demonstrate that publication incentives for university scientists and industrial researchers are converging. Upgrading absorptive capacity and getting an entry ticket into university science are now perceived as important incentives for firms to publish their results despite the general norms of disclosure in the business sector according to the economics of science.

Other recent empirical contributions demonstrate that academic socialization influences knowledge disclosure of the individual scientists and to which degree he or she participates in knowledge transfer activities. For instance, McFetridge (1993) concludes that Canadian academics are relatively immobile and have no incentives to engage in entrepreneurial activities.

Thursby and Thursby (2002) demonstrate that many academic scientists are still behaving according to the values and norms of disclosure valid in the community of science. Their article provides three motivational reasons why individual faculty members choose not to disclose their knowledge for commercial activities and thus to participate in transfer activities:

- Faculty members specialized in basic research do not disclose because they are unwilling to spend time to applied research necessary to attract businesses;

- Unwilling to risk publication delays associated with patenting that may be require to interest industrial partners;

- Value system that commercial activity is not appropriate of an academic scientist.

This is confirmed by (Agrawal & Henderson, 2002), who demonstrate the minor importance of patenting for MIT faculty

2.3 Norms and values of the academic entrepreneur

The literature demonstrates that university scientists besides the academic rules and norms are affected by external interests. The question is the extent of influence and if external constituents make research their tool (Ziman, 2000, p. 171). He takes the argument even further stating that in the current reality of research organised on market principles, where research units take up projects supported by external funding bodies including government and private sector firms, the behaviour of academic scientists are affected by the priorities of the external funding bodies with their vested interests. For example, in the case of the UK, research councils favour projects with wealth-creating prospects; or with practical medical, environmental, or social implications (Ziman, 2000, p. 173). Another example is provided by Adams (2000) who claims that with declining public funding, university laboratories became more dependent on the nature and utility of their research and consequently shifted their research priorities. Industry becomes more important in setting the agenda of research for academic scientists in such a situation (Adams, 2000, p. 82) Ziman notes that a more utilitarian perspective on the economic potential of academic research has gained ground (Ziman, 1994, 2000). In this context, Ziman (2000) notes a shift towards more professional norms among researchers; namely proprietary, local, authoritarian, commissioned expert work (2000, p. 174).

The literature on academic entrepreneurship shows that particular scientific disciplines chose to disclose their knowledge via patenting, licensing and spin-off creation (Owen Smith and Powell, 2003). From the perspective of the economics of science, these entrepreneurial scientists behave according to norms and values which are traditionally associated with industrial researchers.

Individual scientist has the intellectual capital to engage in commercialization activity whether by simply disclosing an invention to a university technology transfer office or starting up a spin-off company. Many studies nowadays refer to academic entrepreneurship and commercialization of knowledge. Is it a general tendency that scientists are increasingly engaged in commercialization of their knowledge or are the successful cases of academic entrepreneurship incidental and are most scientists still driven by the values and norms as expressed by the economics of science?

Some studies on academic entrepreneurship (Owen Smith and Powell 1998)demonstrate that university scientists in some scientific disciplines such as biotechnology chose to disclose their knowledge via patenting, licensing and spin-off creation. It is argued that the potential financial rewards of starting a company coupled with tightening university budgets and competition for the relatively fixed pool of public funding create incentives to engage in entrepreneurial activity and changes the disclosure behavior of academic scientists (Powell and Owen Smith, 1998). From the perspective of the economics of science, these entrepreneurial scientists behave according to norms and values which are traditionally associated with industrial researchers (see also Etzkowitz ,1998).

Moreover, life cycle models of individual scientists demonstrate that scientists invest heavily in human capital early in their careers to build reputation, i.e. reputational reward as we referred before and establish a position in a particular field of expertise (Stephan and Levin, 2002; Stephan 1996, 2004, Bercovitz and Feldmann 2005: 180). Reputational reward is thus very important. In later stages of their career, scientists typically seek an economic return for their human capital, so a financial reward more important. Starting up a company serves the purpose of appropriating the value of their intellectual property as well as providing access to additional funding mechanisms to further the scientist research agenda (Colyvas et al, 2005).

Bercovitz and Feldmann (2005) find that the decision of individual faculty member to participate in technology transfer through the disclosing of knowledge is strongly influenced by

- Training effects, trained at institutions at the forefront of technology transfer are more likely to engage in transfer activities;

- Leadership effects, actions of chair of department, if he is active in technology transfer, members of department also more likely to disclose;

- Cohort effects, behavior is mediated by experience of those in a similar position in terms of academic rank and departmental affiliation. If an individual can observe others at their academic rank disclosing , then they are more likely to participate in technology transfer.

2.4 Summary literature, conceptual framework and propositions

Clearly, studies on university knowledge disclosure and technology transfer show controversial perspectives on the values and norms of the contemporary scientist.

The literature reveals that the community of science has ingrained norms and values, such as communalism, universalism, disinterestedness, originality, and scepticism (Merton, 1973). The community of science is ruled by a reward system facilitating the production of public knowledge (David, 2000). It is based on priority and the constitution of reputation that creates competition, compatible with the disclosure of knowledge. The peer review process is crucial to the building of academic reputation in science where the priority of the discovery is the major value in the reward structure that governs science (Merton, 1973, Whitley, 1984). The tradition knowledge dissemination channel in science is publications and conferences.

The literature on academic entrepreneurship points to the values and norms associated with academic entrepreneurs. A more utilitarian perspective on the economic potential of academic research has gained ground among the university scientist. In fact, a shift is observed from disinterested research of the community of science towards more professional norms among researchers; namely proprietary, local, authoritarian, commissioned expert work (Ziman, 2001). Entrepreneurial scientists behave according to norms and values which are traditionally associated with industrial researchers.

Individual scientist has the intellectual capital to engage in commercialization activity whether by simply disclosing an invention to a university technology transfer office or starting up a spin-off company (Owen Smith and Powell, 2003). Entrepreneurial scientist chose to disclose their knowledge via patenting, licensing and spin-off creation. Based on the literature we develop hypothesis that academic scientists do behave sometimes as entrepreneurs. We will refer to these as the entrepreneurial scientist or academic entrepreneur.

In our cases, we investigate norms towards basic science and norms towards academic entrepreneurship, and the practices of academic scientists focusing on the knowledge disclosure activities of publishing and knowledge transfer through patents and spin-offs and their motivations for these practices. We put forward the following propositions:

PP 1a If the traditional scientific outputs are high of the research unit, we expect that the university scientists of this research unit are primarily motivated by scientific norms and values and are more engaged in basic research activities.

PP 1b If the university scientists are primarily motivated by scientific norms and values, we expect them to be relatively more engaged in scientific knowledge production and scientific knowledge dissemination via publications and conferences.

PP2a If the scientific outputs are low, we expect that the university scientists are relatively less motivated by scientific norms and values and less engaged in basic research activities

PP2b If the university scientists are primarily motivated by entrepreneurial norms and values, we expect them to be relatively more engaged in applied knowledge production and scientific knowledge dissemination via R&D collaboration with industry, spin-offs, and consultancy.

PP3 If the university scientists want to be engaged in entrepreneurial activities with industry, their academic reputation and outputs should be high (condition).

3. Methodology and data

3.1 Selection of the cases

The empirical data comes from the documentary evidence as well as interviews with the four cases of biotechnology research units. The selection of the cases is based on theoretical sampling of basic research units in research universities in the Netherlands and in England (Yin, 2003). The contrasting cases were selected to account for the different institutional environments of research units. The major criterion employed was the estimated research quality of the biotechnology units. It is based on the assumption that the reputation of research unit based on its quality may influence the knowledge disclosure behaviour. Therefore, we distinguish between ‘high achievers’ and ‘middle achievers’ among the research units in biotechnology based on the available RAE evaluations and the evaluations of Dutch visitations. We named the English research units A and B, and the Dutch research units C and D. The following Table 1 provides the overview of the selected cases.

Table 1. The cases

Field of research	England	The Netherlands
Biotechnology	Case A (strong case) Case B (weak case)	Case C(strong case) Case D (weak case)

In our study, the unit of analysis will be research groups within departments; institutes or research centres that have their own administrative, physical, and academic existence. These basic research units have their own organisational behaviour and setting and are supposed to act on the basis of the unit’s interests and those of its individual members. Biotechnology is considered to be a typical Mode 2 field of research as noted by Gibbons et al. (1994) in their study of the relationship between policy and developments in academia. Its supposed characteristics are fluidity; discovery in the context of application; problem oriented transdisciplinary knowledge organised more loosely in changing teams; applying relevance criteria for research; and networking with corporations and their research units, hospitals, and non-university public research institutes (Rip, 2002, p. 46).

3.2 Measurements for values and norms of university scientists in the cases

The data collection implied using multiple sources of evidence under the rationale of triangulation (Yin, 2003). The study used documents, literature, and semi-structured interviews. The documents and the literature address the period since the 1980s. The interviews took place in October 2005 – January 2006 in the Netherlands and England. 33 interviews were conducted with researchers, university managers, and policy-makers.

The knowledge disclosure is operationalized as two types based looking at the communication channels. One is traditional scientific type, such as publishing in scientific journals, attending conferences and being involved in the scientific community. The second type is the entrepreneurial knowledge disclosure behaviour that relates to the outside world to the scientific community – such as producing patents, creating spin-off companies, having PhD students paid by industrial partners. We expect that if scientists are involved in the first type knowledge disclosure activities, they are less inclined to get involved in the entrepreneurial type of activities.

3.3 Characteristics of selected research units

The research units work as interdisciplinary research units, where different sub-groups are formed according to different projects although the group as a whole works in the same over-aching topic. The four research units differ in the area of specialization. A is involved in structural biology: protein crystallography and B in biomaterials: biosensors, cell and tissue engineering. C works in the field of functional genomics and D specializes in proteomics. All research units had PhD students and post-docs working for the PIs in the laboratories, with the group leader being a professor. The number of professors per research unit ranged from two to fifteen (see Table 2). All research units work in partnership with other universities and industry although to a different extent as the units differ according to the emphasis on basic and applied research.

In terms of resources, due to the last grading of the RAE and the stop of their core funding from the Department of Trade and Industry, B experienced a funding decrease. Moreover, they are going to be restructured and integrated in one department and academics have to teach more than they did before. A on the contrary, due to the improvement of the RAE score got more funding, new posts were created, the building refurbished, new equipment installed. Researchers have less teaching load since 70% of their time go to research. Research in both units is mainly funded from external sources such as the private charities, research councils, industry as well as the European Union.

In the Netherlands, D is in a more favourable position in terms of resources than C. D is a part of a bigger research network and its leader has received a big national project that provides funds for upgrading equipment. Moreover, university has a special fund for multidisciplinary projects and a part of their funds comes from there. C is in a different situation, although it does not need to struggle financially, but the Faculty where it is located itself is under financial strain. Due to the problems in the faculty, C cannot hire new staff, although the group itself is self-sustainable from external funding sources, such as grants and research projects (NWO, NWO-BMI, IOP-Genomics). Since the first stream funding is reported to have decreased around 20%, the second and third stream funding has increased. This includes NWO, European Union external funds as well as contract research with industrial partners.

Table 2. Characteristics of the English and Dutch biotechnology research units (2005)

	Funding of the Department/Institute	**Size of the research unit**	**Specialisation**
Case A	High (€6 M in 2000 and increased since then)	38 FTE, 15 professors, 19 postdocs Staff stable	Protein crystallography
Case B	Low (€2 M in 1999/ 2000 – decreased since then)	14 FTE, 6 professors, 20 postdocs Staff reduced	Biosensors
Case C	High (€10 M in 2005)	14 FTE, 2 professors, 8 postdocs, Staff reduced	Functional genomics
Case D	High (€12 M in 2004)	24 FTE, 10 professors, 12 postdocs, Staff stable	Proteomics

As reported by the research units, their institutional environment has changed in terms of increased pressures to produce research outputs and to acquire external research funding in order to be able to carry out research. This has been coupled with the requirements of the research evaluation stemming from the ‘visitations’ or RAE as well as yearly performance monitoring by the management which result in a tightly monitored research environment.

4. Empirical findings

In the former section (3.2), it was demonstrated that the research units differ in their perceived research quality. The English research unit A and Dutch research unit C got excellent research quality scores in the peer-review research assessments, while the English unit B and the Dutch unit D got good scores.

Biotechnology researchers from our case studies disclose their knowledge to different audiences, such as the scientific community and industry. Following the RAE and the Dutch visitations peer reviewed articles are the dominant channel of knowledge disclosure. Most of their research is funded either by research councils, the European Union, charities or industry and they largely influence the choice of the medium of knowledge disclosure and the type of research carried out. Academics enumerated publications, patents, spin-offs, links with industry, grants, conference papers, reviews, participation in committees, consultancy services and invitations to speak as their outputs. The key idea behind producing them is to contribute to the researcher’s standing in the academic community, get funded as well as contribute to the country’s economy at large. B and C work more on the ‘applied side’ than A and D as perceived by the researchers themselves.

4.1 Scientific norms and values of scientists

In all units, following the aspiration of academic credibility and anticipating the quality assessment evaluations, journal articles are the dominant medium of knowledge disclosure. There is a strong internal drive to publish. By means of group leaders and deans and heads of departments, the organisation explicitly encourages academics to publish. A junior from C notes that they are evaluated once per year and there is an expectation of two published articles per year to be positively evaluated by their leader. A usual instrument used in the units to encourage researchers to publish is to stimulate conference attendance. The D group leader encourages this also because it enhances the unit's visibility. A usual routine for biotechnology units is to vastly collaborate, especially while aiming for the top journals.

The pressure to publish is also coupled with the external quality evaluations, which take articles as an important assessment criterion, and with university management, which also takes stock of the outputs produced by every research group in their institution. Finally, researchers mention external funding bodies that increasingly look at the number of publications when they are deciding on project funding. The emphasis is laid on publications in high rated journals and it is perceived as a new phenomenon as noted by a professor from A: 'I suppose if you look back thirty years nobody would have bothered so much. But it was a different world 30 years ago.' They help build credibility and identify their standing in the field.

The encouragement to publish means in fact a strong emphasis on scientific journals instead of books or popular articles and reviews. Articles in highly rated journals are basically all that counts (see Table 3). Researchers in both groups are very conscious about the citation indexes and about the impact factors of journals and are not interested in "wasting time and effort" on writing books or book chapters, unless it concerns "a very prestigious series". The C leader well expresses that he is quite selective about what to publish:

> I don't like [writing books] anymore I must say because they are not in Netline, in Putnet. So you don't get your citation indexes from that and I get quite a lot of invitations for books but I'm very hesitant to take them. Only when they are very famous book series such as 'Methods in Enzymology' or something, then yes, but not for just another microbiology book. I usually don't do that anymore. It's too much effort, it takes your time and I can make a review when I have time for a journal; I also prefer that.

Table 3. Scientific outputs of the selected English and Dutch research units

	RU research quality	Number of successful dissertations	Number of memberships of scientific advisory councils	Number of research prizes/awards	Number of articles in peer reviewed journals	Number of editorships in journals and book series
Department of Case A	High (5* in RAE 2001)	**30** (02/03)	**50** (02/03)	**2** (02/03)	**180** (02/03)	**35** (02/03)
Institute of Case B	Low (4 and 5 in RAE 2001)	**4** (02/03)	**20** (02/03)	**0** (02/03)	**50** (02/03)	**6** (02/03)
Institute of Case C	High (four times 5 in 2004)	**25 (2004)**	**Dutch funding agencies, ESF, EU**	**1 (2004)**	**135 (2004)**	**6 (2004)**
Institute of Case D	Lower (three times five in 2004)	**3 in the unit (2004)**	**Dutch funding agencies and professional organizations**	**4 in the unit (2004)**	**192 in the larger institute (31 in the unit) (2004)**	**N/A**

Source: RAE 2001 statistics, Dutch visitations' results, Annual reports (2004), *author's questionnaire to the department/institute managers.*

As indicated in the Table 3 and in the interviews, the major values of biotechnology research units are to assure the continuity of the research lines of the academics' preference and to build academic credibility through publishing in high impact international journals. At the same time, publishing in journals is vital to prove to the management their performance. This translates into the routine publishing, both quality and quantity matter. To meet the targets, researchers follow various publishing routines. The obvious one is to publish routinely the required number of publications for the RAE or the yearly appraisal: "that is my strategy and that is the only strategy to survive, as far as I can see". The common behaviour of research units is to go for the quality journals and while aiming highest also not to forget about the quantity, that is, to publish as often and as much as they can. Besides quality they consider how fashionable the topic is and what the likelihood is to be published in the top international journals. Impact factors are the name of the game as the group leader from A notes:

> Publications are essential and it's also clear that those publications have to have an impact on the field and therefore most people know that they need to get into the journals which are the most widely read and cited. It's important for their own work to be reviewed in journals where they are going to have a high impact.

Citation indexes are taken into consideration, as this is one of researcher's evaluation criteria and the major value behind is furthering and transmitting the scientific knowledge, as high impact factor journals are widely read among the scientific community. A professor from C exemplifies that it is important to bear in mind the citations coming out of an article:

> If it is a very big step and very novel, new [research], you have got ‘Nature’ [to publish in]. After that it is really building on research that you can publish in other magazines. But getting into Nature is not the final goal … it’s all about getting cited. You can make a big/high claim/research and nobody will read it. If you make it a bit less high profile, everybody will use it and put it in their reading cabinet. Citations, that’s what makes you further scientific knowledge.

Further, since all research units were concerned about the continuity of funding since they want to make sure they can constantly build their academic credibility and continue their lines of research, they also followed certain routines to offset the lack of continuity. They combine short-term outputs and themes into a long-term theme and more substantial outputs. For example, in A the head of the group indicates that they manage to get grants one after the other so they can maintain longer term research that leads to bigger projects and credibility within that area. This is shared by the senior researchers in B who find it difficult to maintain continuity. The B leader notes that researchers are creative about maintaining the lines of research and the stable production of outputs. Other respondents from D also stress the need to balance short-term outputs and the long-term research programme. In this case the research unit manages to get grants on a regular basis, so they can maintain credibility in a particular area. The group leader of D notes:

> The kind of work is the same but the specific subject you’re studying within the micro organism … might vary, although I try to also get of course continuation in that like anti-microbes. We have done that for 20 years already and some metabolic regulation, we also try to do that for longer term. Of course if you want to be recognized in the field you have to have some long term show. Project with one theme for once and then ended and doing something else is not ideal. But sometimes it happens.

In contrast, C is less concerned about balancing short and long–term projects. They are positive about three year contracts and think it is enough to produce journal publications.

However, the professors in this unit also maintain the 'red line' in their research, which means they work on the same over-aching research topic and try to ensure continuity by building on short-term outputs. In all units, however, academics are concerned that their PhD students graduate on time and get 'publishable' results. Thus, there is a strong value attached to the produced PhD thesis. The completion rates of PhDs (see Table 3) are important for the funding and reputation of the research units.

4. 2 Entrepreneurial norms and values of university scientists

Both Dutch and English biotechnology research units are keen on collaboration with industry though consultancy services as well as collaborative research projects (using the shared facilities or company funded PhD students). This is particularly visible in the units carried out more applied type of research, such as B and C (See Table 4). There is a tendency that certain external funding bodies such as the EU or research councils favour 'relevant' research, and this is perceived as a push for researchers to think about their research in the context of application. For example, a researcher from research unit A admits, that he would be more likely to get funding if he would go for applied research project and likes the idea of doing that:

> 'I think the funding bodies would like us to do more applied research. I'll be happy to do more applied research, I just can't currently see in many avenues where I can take my work. I would be quite happy to do a little more applied research I just currently struggling to see what that will work and be able to do that. I feel that I'm more likely to get research funding going that way as well. And to be fairer might be more stimulating. I'd might actually enjoy it.'

The group leader of B noted that different funding bodies would fund different types of research. For instance, while the Department of Health, the Department Trade and Industry in England and the European Union would fund more applied research. The research unit with less academic credibility and resources opts for more applied type of research.

In the Netherlands, a C junior draws attention to the relevance of their research, and relates this to their cooperation with industry and is in part subsidized by the Ministry of Economic Affairs: "The relevance comes from the fact that we obtain quite some money from industry. We do want to implement our research data…so there is the relevance". At the same time, although D is more oriented towards basic research, relevance is an important consideration. For example, if there is a choice to be made about the 'relevance' of research, then a professor from D goes for it:

> If you have to decide to work on a protein that is involved in a very important disease or a protein which is equally interesting but involved in degradation of metabolising yeast, then you choose for the one that has medical relevance. Maybe the project itself is not that interesting but the potential impact is better, so then you decide on that project. In that respect it influences your research.

The applicability of knowledge (relevance of the research) is a good and serious criterion in selecting research projects according to this professor. At the same time, he recognizes that this cannot always be the leading criterion because it is also important to retain the major basic research lines intact. A balancing act, in which basic and applied research project call for priority, is the result.

Table 4. Entrepreneurial activities of the selected English and Dutch research units

	RU research quality	Joint projects with public and private organizations outside the academy	Number of spin off companies	Number of patents	Services to industry	Research funded by company
Case A	High (5*)	Major pharmaceutical companies	**3 (96-2001)**	**21 (96-2001)**	**36 consultancies with pharma**	**1 lab funded by company (1996-2001)**
Case B	Low (4 and 5)	Hospitals	**4 (96-2001)**	**33 (96-2001)**	**Consultancy services (ISO**	**Industrial Affiliates**

					9001 and UKAS systems acquired)	**Club (1996-2001), the Foundation affiliated to the Institute**
Case C	High (four times 5)	Dutch life science industries (RFF, DSM, Unilever, Avebe, Fuji Film, Diosynth), International (BASF, Danisco, Nestle)and public research institutes	**N/A**	**22 (96-2001) 7 (2005)**	**Consultancy services**	**1/3 projects are funded by EU projects and contract research with companies (2004), research hotel**
Case D	Lower (three times five)	Collaboration with public research institutes, the University hospital, Dutch life science industries (DSM, Unilever)	**N/A**	**N/A**	**Consultancy services**	**25% of postdocs funded by company, 15% PhD students funded by company (2004), research hotel**

Sources: RAE 2001 statistics, Dutch visitations' results (2004), Annual reports (2004), author's questionnaires to the department/institute managers.

Patents are mentioned as an important channel of knowledge disclosure by all research units but are perceived as less rewarding than articles. For them, patenting procedures are time consuming, take a lot of effort, and the benefits are negligible. They can be counter productive for their academic credibility building. Time lags, due to patenting, can have serious effects, as shown by a C junior researcher who had to wait for one year to have his PhD published because of the patenting procedure:

> If you go for a patent then there is a delay. For instance, when I finished my thesis I had this nice booklet but there was interest in patenting. One had been patented the second year already, so that was out, there is one year protection, twelve months at least, so there was an interest and that was filed at the moment I finished my thesis. But that meant I had to wait for one year. Ok, I had a job and could continue, but the booklet is there for a year just waiting for defense. It was not allowed to be made public.)

There are patenting offices at the universities that are supposed to support the academics. Many researchers question the added value of these offices. Basically, the academics argue that the patenting offices do not provide many incentives for patenting. Researchers are also concerned about the very low success rates of patents. A junior respondent from C refers to EU regulation that bans patents in a certain molecular genomics areas. In the end, the researchers argue that patents do not bring much money, whilst they require a lot of effort. From their point of view, patents are not that rewarding. Additional problem with patents is competition and that can block university research as experienced by a junior researcher and this goes counter the values of knowledge dissemination of science and the expectation to build academic credibility:

> 'In my case, I filed two and got one patented with is the basis for the whole company thing. What was interesting with that is that we had some other

> ideas about things a few years ago which we didn't patent and now that area has been completely patented to hell as it where…. Whereas these days a lot of big companies are just blankly patented that they have no idea what they wanted to do with it, which doesn't leave much room for trying who wants actually to do something. So somebody may have patented something without really thinking about what it is was that they were doing. And then somebody else would come along, any university will come along, oh, this would be really good to send somewhere and finally will find out that they can't do anything with it.'

Despite the hesitations, researchers in B and C are aware that patents may be useful for their future career since they count as publications on their CVs and can bring added value even though they are not the core activity. Nevertheless, they prefer to publish a journal article and not waste too much energy on patents. This creates some tensions with central management since they would like to see a growing number of patents for the university. In sum, research units researchers largely ignore and challenge the call for getting more patents (especially in the Netherlands). Although university management is keen on getting patents, most researchers argue that this is a rather pointless endeavor. They are hardly willing to go this road of 'commercialization' and 'entrepreneurship' (see Table 4).

5. Conclusions

Based on the evidence from the biotechnology research unit scientific and entrepreneurial activities a mixed picture emerges. Irrespective of their academic reputation and the amount of research outputs, the major tendency is to adhere to the scientific values and routines. All of them are keen on publishing journal articles and are very much aware of the scientific value of knowledge dissemination to the academic community. High impact journals are the name of the game to a large extent. In addition to the scientific norms, the routines encouraged and maintained by the university management, such as appraisals, external evaluations call for quality and quantity of the research publications. Finally, the UK context the results of the external evaluations are directly linked to the funding levels of the Funding Council, which brings the peer review judgment of the journal articles to the fore. In both countries, the competitive grant bidding of the research councils in many cases means that academics need to have a good publication track record in order to obtain the grants. Thus, the academic values of communalism, universalism, disinterestedness, originality, and scepticism are reinforced by the community of science, university management as well as external public funding bodies.

On the other hand, a mixed picture emerges when we consider the entrepreneurial activities of the research units. All of them are involved in collaboration with the industry and are aware the importance of industry funding for their survival. Increasingly, their budgets depend on external third stream funding and commercialization activities are encouraged by the university managers. We can see that in the cases of high academic reputation they maintain more basic research and can afford to do so through the major research council and university funding (first and second money streams). At the same time, in order to fit the priorities of the external funders, they try to be ‘relevant’ in their topic selection and also though entrepreneurial initiatives of creating spin off companies and patenting. In the cases of lower research reputation we can see more applied research activity taking place, although the external funding is a mixture of second and third stream funding as it is in the high reputation units.

The preliminary findings suggest that the research units have to deal with a precarious balance between the norms and practices ingrained in their field, the need to satisfy the requests of external and internal evaluations, and the expectations of their financial backers, either governmental or industrial. Increasingly diverse audiences try to define the kind of outputs expected from units. Academic community is no longer the ultimate and the only audience towards which academics orient themselves. The role of university management is often important in encouraging the diversification of funding base and seeking for new audiences which often uses new rules and introduces new routines for research units. Patents are a prime example of the outputs encouraged by the university management.

In general, the research units do not appreciate these kinds of demands. They wish to invest their time into credible outputs for the academic community. Additionally, patents can be a lock-in for researchers who want to make the outcomes public as soon as possible. All of them think that patents hardly pay off in terms of costs and benefits. Tensions also emerge from ambivalent signals and partly contradictory expectations that the research groups face. On the one hand, major research evaluations and funding streams are based on expectations of academic excellence. On the other hand, the research groups experience a growing rhetoric of 'relevance' that does not really pay off in terms of reputation and funding in the academic community.

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